PATENT

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Applicants:	Louis A. Rigali et al.
Serial No:	Unknown (Continuation of Serial No. 09/012,743)
Filing Date:	April 9, 2001
Title:	HIGH THROUGHPUT PLASMA TREATMENT SYSTEM
Atty Docket:	NOR-953B

Cincinnati, OH April 9, 2001

BOX PATENT APPLICATION
Assistant Commissioner of Patents
Washington, D.C. 20231

Sir:

PRELIMINARY AMENDMENT

Prior to examination, please preliminarily amend this application as follows:

IN THE SPECIFICATION:

Please amend the first paragraph of the specification as follows:

This application is a continuation of U.S. Application No. 09/012,743, which was filed on January 23, 1998, which is a continuation-in-part of U.S. Application No. 09/601,687, which was filed on February 15, 1996 (abandoned), which is a continuation-in-part of Application No. 567,797, filed December 5, 1995, now Patent No. 5,766,404, which is a continuation-in-part of Application No. 350,320, filed December 5, 1994.

Please amend the paragraph beginning on page 19, line 6 as follows:

As is shown in Fig. 3b, after the last PC board 28' has been loaded, the first catch finger 70 is raised and the push mechanism 20 is moved by the linear drive assembly 22 to a location outside of the perimeter of the chamber base 16. At the same time, the conveyor position actuator 32 moves the conveyor 30 back out of the reaction chamber 14 area as well. The reaction chamber 14 is then lowered by the chamber lift actuators 40 onto the chamber base 16, whereon the reaction chamber 14 is vacuum-tightly fittable, and the plasma process is initiated. Referring again to Fig. 2, there is shown a vacuum and plasma generating system 27 having a number of elements of generally conventional nature. A vacuum port 90, to which is connected a vacuum pump (not shown), provides that the reaction chamber 14 may be evacuated to a predetermined level, which is generally in the so-called "soft vacuum" region of 0.1-1.0 mm Hg. A gas distribution manifold 92

allows for the continuous introduction of process gas (e.g., oxygen and argon) within the reaction chamber 14. Flexible Teflon® tubing (not shown) provides that the gas manifold 92 may be raised in conjunction with the reaction chamber 14. A plasma is generated within the evacuated reaction chamber 14 with a radio frequency generator 94, there being provided for this purpose four radio frequency feedthroughes 96 which are located in the chamber base 16. An electrode 98 for the application of high voltage, to which the chamber guide rails 52 are clamped with guide rails clamps 100 (see Fig. 1) and conveniently supported thereby, provides that plasma reaction may then occur at the surface of the PC boards 28. It will be apparent to those with ordinary skill in the art that other electrical and radio frequency configurations for the chamber guide rails 52 might be employed. Thus, the chamber guide rails 52 might be radio frequency powered, or grounded, or electrically "floating" (isolated), or some combination of the foregoing. Additionally, a DC bias circuit can be included in the plasma treatment system to increase the directionality of plasma flow and the energy level of the ions and electrons in the plasma. The higher energy level also increases the ionization rate, thus increasing the number of ions and electrons. The increased energy level and increased ionization rate both act to produce a higher etching rate and thus a short processing time. The increased bias also results in a more directional flow of ions onto the parts, resulting in a more anisotropic etching which is required when etching holes and vias. Anisotropic etching provides straight wall etching which

decreases undercutting. This DC bias circuit is discussed in more detail below (see Fig. 12).

IN THE CLAIMS:

Please cancel claims 1-27.

Please add new claims 28-64 as follows:

28. A system for the plasma treatment of a plurality of parts at one time, comprising:

a reaction chamber having an open bottom;

a chamber base sealingly engageable with said bottom of said reaction chamber to form a treatment chamber;

a lifting device coupled with said reaction chamber and operable to lift said reaction chamber from said chamber base;

a guide along which each of the plurality of parts may be moved;

a transfer mechanism operable to transfer the plurality of parts along said guide to a plurality of treatment positions within said treatment chamber when said reaction chamber is disengaged from said chamber base;

a plasma-generating device operable to produce a plasma within said treatment chamber for treating the plurality of parts; and

an electronic control system that controls said transfer mechanism for transferring the plurality of parts to said plurality of treatment positions.

29. The system of claim 28, wherein said transfer mechanism comprises:

a vertically-positionable transfer arm capable of selective engagement with each of the plurality of parts; and

a linear drive assembly for moving said transfer arm along the length of the treatment chamber.

30. The system of claim 28, further comprising:

a first position actuator and a second position actuator positioned on opposed ends of said treatment chamber, said first and second position actuators capable of horizontal movement,

an input carrier mounted on said first position actuator, said input carrier including a conveyer capable of conveying each part to a location adjacent said guide; and

an output carrier mounted on said second position actuator, said output carrier comprising a conveyer capable of conveying each part to a location removed from said guide.

31. The system of claim 28, wherein said electronic control system further comprises a plurality of sensors that provide information regarding the position of said transfer mechanism.

32. The system of claim 28, wherein said guide is located within said treatment chamber when said reaction chamber is fitted to said chamber base.

33. The system of claim 32, wherein said plasma generating device includes an electrode and said guide is mounted to said electrode.

34. The system of claim 33, wherein said guide is capable of supporting the plurality of parts when the plurality of parts are positioned in said plurality of treatment positions.

35. The system of claim 32, wherein said guide is capable of supporting the plurality of parts when the plurality of parts are positioned in said plurality of treatment positions.

36. The system of claim 28, wherein said electronic control system comprises a microprocessor interfaced with said transfer mechanism by SMEMA communication.

37. A system for the plasma treatment of a plurality of parts at one time, comprising:

a reaction chamber having an open bottom;

a chamber base sealingly engageable with said bottom of said reaction chamber to form a treatment chamber;

a lifting device coupled with said reaction chamber and operable to lift said reaction chamber from said chamber base;

a plasma-generating device operable to produce a plasma within said treatment chamber for treating the plurality of parts, said plasma-generating device including a plurality of vertically spaced horizontal electrodes;

a plurality of vertically spaced guides forming multiple levels along which the plurality of parts may be moved to a plurality of treatment positions within the treatment chamber, each of said plurality of guides associated with a respective one of said plurality of horizontal electrodes; and

a transfer mechanism operable to transfer the plurality of parts along said plurality of guides to said plurality of treatment positions.

38. The system of claim 37, further comprising an electronic control system that controls said transfer mechanism for transferring the plurality of parts to said treatment positions.

39. The system of claim 37, wherein said plurality of guides comprises a plurality of horizontally spaced guide rail pairs adapted to receive respective ones of the plurality of parts therebetween.

40. The system of claim 37, further comprising:

an input carrier operable to convey each of the plurality of parts adjacent said plurality of guides; and

an output carrier operable to convey each part to a location removed from said plurality of guides,

said input and output carriers each capable of carrying the plurality of parts along said multiple levels.

41. The system of claim 40, wherein each of said input and output carriers is horizontally and vertically movable for positioning said input and output carriers adjacent to said plurality of vertically spaced guides.

42. The system of claim 37, wherein said plurality of guides is located within said treatment chamber when said reaction chamber is fitted to said chamber base.

43. The system of claim 42, wherein each of said plurality of guides is mounted to a respective one of said plurality of horizontal electrodes.

44. The system of claim 43, wherein said plurality of guides are capable of supporting the plurality of parts when the plurality of parts are positioned in said plurality of treatment positions.

45. The system of claim 42, wherein said plurality of guides are capable of supporting the plurality of parts when the plurality of parts are positioned in said plurality of treatment positions.

46. A system for the plasma treatment of a plurality of parts at one time, comprising:

a treatment chamber;

a first horizontal electrode and a second horizontal electrode, said first and second horizontal electrodes facing each other within said treatment chamber, said first horizontal electrode capable of supporting the plurality of parts;

a vertical electrode electrically coupled to one of said first and second horizontal electrodes, said vertical electrode positionable adjacent the plurality of parts; and

a plasma-generating device operable to produce a plasma within said treatment chamber for treating the plurality of parts, said plasma generating device electrically connected to at least one of said first and second horizontal electrodes.

47. The system of claim 46, further comprising a plurality of part supports positionable on one of said first and second horizontal electrodes, said part supports arranged in a multilevel array to support the plurality of parts.

48. The system of claim 47, further comprising a magazine and said plurality of part supports further comprise a plurality of slots in said magazine, the plurality of parts positionable in said plurality of slots.

49. A system for the plasma treatment of a part, comprising:

a reaction chamber having an open bottom;

a chamber base sealingly engageable with said bottom of said reaction chamber to form a treatment chamber;

a lifting device coupled with said reaction chamber and operable to lift said reaction chamber from said chamber base;

a guide along which the part may be moved;

an input carrier adapted to hold the part adjacent to said guide prior to transfer into the treatment chamber;

an output carrier adapted to receive the part from said guide following plasma treatment;

a transfer mechanism operable to transfer the part along said guide when said reaction chamber is disengaged from said chamber base; and

a plasma-generating device operable to produce a plasma within said treatment chamber for treating the part.

50. The system of claim 49, wherein said transfer mechanism is vertically and horizontally positionable relative to said guide.

51. A method for the plasma treatment of a plurality of parts in a system including a treatment chamber and a transfer mechanism operated by an electronic control, the treatment chamber formed by a reaction chamber capable of selective sealing engagement with a chamber base, the method comprising:

disengaging the reaction chamber from the chamber base;

sending loading signals from the electronic control to the transfer mechanism;

loading the plurality of parts at a plurality of treatment positions within the treatment chamber based on the loading signals;

sealingly engaging the reaction chamber with the chamber base;

evacuating the treatment chamber to a subatmospheric pressure;

generating a plasma to treat the plurality of parts within the treatment chamber;

venting the treatment chamber to a pressure above the subatmospheric pressure;

disengaging the reaction chamber from the chamber base;

sending unloading signals from the electronic control to the transfer mechanism; and

unloading the plurality of parts from the treatment chamber based on the unloading signals.

52. The method of claim 51, wherein the unloading step comprises:

providing a first part of the plurality of parts outside of the treatment chamber;

engaging the transfer mechanism with the first part;

moving the transfer mechanism to position the first part at a first treatment position within the treatment chamber;

providing a second part of the plurality of parts outside of the treatment chamber;

engaging the transfer mechanism with the second part; and

moving the transfer mechanism to position the second part to a second treatment position.

53. The method of claim 52, wherein the first engaging step further comprises:

moving the transfer mechanism horizontally to a position suitable for engaging the first part; and

lowering the transfer mechanism to engage the first part.

54. The method of claim 53, wherein the second engaging step further comprises:

moving the transfer mechanism horizontally to a position suitable for engaging the second part; and

lowering the transfer mechanism to engage the second part.

55. The method of claim 52, wherein engaging the transfer mechanism with the second part comprises:

raising the transfer mechanism such that the part-engaging member can be moved horizontally without engaging the second part;

moving the transfer mechanism horizontally to a position suitable for engaging the second part; and

lowering the transfer mechanism to engage the second part.

56. The method of claim 52, further comprising:

detecting the presence of one of the plurality of parts outside of the treatment chamber;

sensing the position of the transfer mechanism during the moving steps; and

repeating the providing, engaging and moving steps until the plurality of parts are positioned at the plurality of treatment positions within the treatment chamber.

57. The method of claim 51, wherein the unloading step comprises:

engaging the transfer mechanism with a first part of the plurality of parts;

moving the transfer mechanism to position the first part outside of the treatment chamber;

engaging the transfer mechanism with a second part of the plurality of parts; and

moving the transfer mechanism to position the second part outside of the treatment chamber.

58. The method of claim 57, further comprising:

sensing the position of the transfer mechanism during the moving steps; and

repeating the engaging and moving steps until the plurality of parts are unloaded from the treatment chamber.

59. A method for the plasma treatment of a plurality of parts in a system including a treatment chamber formed by a reaction chamber capable of selective sealing engagement with a chamber base, and a plurality of vertically spaced horizontal electrodes in the treatment chamber, the method comprising:

disengaging the reaction chamber from the chamber base;

loading the plurality of parts at a plurality of multi-level treatment positions within the treatment chamber;

sealingly engaging the reaction chamber with the chamber base to form the treatment chamber;

evacuating the treatment chamber to a subatmospheric pressure;

energizing the plurality of vertically spaced horizontal electrodes and thereby generating a plasma within the treatment chamber;

treating the plurality of parts with the plasma;

venting the treatment chamber to a pressure above the subatmospheric pressure;

disengaging the reaction chamber from the chamber base; and

unloading the plurality of parts from the treatment chamber.

60. The method of claim 59, wherein the step of loading further comprises:

sending control signals from an electronic control system to a transfer mechanism; and

moving the plurality of parts with the transfer mechanism to the plurality of treatment positions based on the control signals.

61. The method of claim 59, wherein the step of unloading further comprises:

sending control signals from an electronic control system to a transfer mechanism; and

moving the plurality of parts with the transfer mechanism out of the treatment chamber based on the control signals.

62. A method for the plasma treatment of a plurality of parts in a system including a treatment chamber formed by a reaction chamber capable of selective sealing engagement with a chamber base, a magazine holding the plurality of parts, and a horizontal electrode and a vertical electrode mounted in the treatment chamber, the method comprising:

disengaging the reaction chamber from the chamber base;

loading the magazine to a position adjacent the horizontal and vertical electrodes within the treatment chamber;

replacing the reaction chamber to sealingly engage the chamber base and form the treatment chamber;

evacuating the treatment chamber to a subatmospheric pressure;

energizing the vertical and horizontal electrodes and thereby generating a plasma within the treatment chamber;

treating the plurality of parts with the plasma;

venting the treatment chamber to a pressure above the subatmospheric pressure;

disengaging the reaction chamber from the chamber base; and

unloading the magazine from the treatment chamber.

63. The method of claim 62, wherein the magazine is a first magazine holding a first plurality of parts and the system further comprises a second magazine holding a second plurality of parts, and the step of loading further comprises:

positioning the first and second magazines on opposite sides of the vertical electrode.

64. The method of claim 63, wherein the step of loading further comprises supporting the magazine with the horizontal electrode.

REMARKS

By this Preliminary Amendment, claims 1-27 have been canceled and claims 28-64 have been added.

Early and favorable consideration of this application is respectfully requested.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOWN CHANGES MADE

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undercutting. This DC bias circuit is discussed in more detail below (see Fig. [120] 12).

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